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PRESS CAMERA WITH POLAROID BACK TECHNIQUE FOR PERSONNEL SUBSYSTEM TEST AND EVALUATION

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St. Louis, Missouri

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Eastern Division

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AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

This report was prepared by the Human Performance Laboratory of the Engineering Psychology Department, McDonnell Douglas Corporation, St. Louis, Missouri. This project was conducted for the Personnel and Training Requirements Branch, Training Research Division, Air Force Human Resources Laboratory, Wright Patterson Air Force Base, Ohio. Charles O. Hopkins was the study manager. Cyrus D. Crites was the principal investigator. The research was conducted under Contract F33615-68-C-1476 during the period 15 May 1968 through 15 July 1969. This report was submitted by the author on 20 September 1969.

The research was conducted in support of Project 1710, "Human Factors in the Design of Training Systems," and Task 171006, "Personnel, Training and Manning Factors in the Conception and Design of Aerospace Systems." Dr. Gordon Eckstrand (HRT) was the Project Scientist and Mr. Melvin T. Snyder (HRTR) was the Task Scientist. Mr. J. Peter Kincaid (HRTR) served as the contract technical monitor.

This project deals with three techniques for Personnel Subsystem Test and Evaluation. This document defines the press camera with Polaroid back technique, the other two are described in AFHRL-TR-69-16 "Miniature Event Recording as a Technique for Personnel Subsystem Test and Evaluation," and AFHRL-69-18 "Video Tape Recording as a Technique for Personnel Subsystem Test and Evaluation."

The author wishes to thank government and contractor personnel of the F-4E Category I, II, and III tests for their participation in this research. Significant contributions in the form of assembly, checkout, operation and maintenance of the camera system were made by John Gunnarson.

This technical report has been reviewed and is approved.

Gordon A. Eckstrand, Ph.D
Chief, Training Research Division
Air Force Human Resources Laboratory

ABSTRACT

A study was performed to develop new Personnel Subsystem Test and Evaluation (PSTE) techniques for use during Categories I, II, and III Testing of ground operator and maintenance functions. This report describes the development, modification, and refinement of a press camera system as a PSTE technique. Equipment and operational procedures developed for the technique were evaluated under various conditions, including Category II Testing at an Air Force base. Results showed the utility of the camera technique for human engineering and task assessment. Specific recommendations are given for use of this technique from system concept through operational use.

SUMMARY AND CONCLUSIONS

Problem: The human component of complex Air Force weapon systems constitutes a vital part of the system. If such things as personnel manning, or human engineering of the system are done haphazardly, the efficiency of the system will be degraded, cost of carrying out the system's mission will go up, and personnel operating and maintaining the system might even be placed in danger. To guard against mistakes like this occurring and to insure that Air Force systems are well designed from the human standpoint, systems under development are subjected to a process known as Personnel Subsystem Test and Evaluation (PSTE). The purpose of PSTE is to check the various Personnel Subsystem elements (e.g., Human Engineering, Qualitative and Quantitative Personnel Requirements Information, Training Equipment) for their adequacy during various stages of system development (Category I, II, and III testing.) In principle, the PSTE process should insure that systems are well designed from the human factors standpoint. In practice, PSTE has not always been effective. One reason for this is that PSTE has usually been concentrated late in the system development process (e.g., Category II Testing). By this time, system design is frozen to the extent that changes are enormously costly and time-consuming. Changes are generally instituted only when a safety problem exists, or when modification in a training procedure seems practical. Another reason for this is that the measurement tools used for conducting PSTE have typically been restricted to interviews, checklists and questionnaires. The research problem, then, was to develop a number of PSTE techniques that objectively measure human performance in a systems environment. Further, it had to be demonstrated that these techniques as used in a field system testing exercise could impact system design. To do this, the techniques had to be applied in situations before design is completely fixed and they had to produce convincing enough data to persuade design engineers, Category test officials and System Program Office (SPO) personnel to institute design and/or procedural changes.

Approach: Three techniques were chosen for development and field testing. Besides a press camera with a Polaroid back, these included a video tape recorder (covered in AFHRL-TR-69-18 and a miniature event recorder (AFHRL-TR-69-16). The systems selected as test vehicles (various models of the F-4 aircraft) were undergoing Category II Testing at Edwards AFB, California, and Nellis AFB, Nevada. Subsystems included in the study were the AN/APQ Radar, the Martin Baker Mark H7 rocket ejection seat and the Rockeye MK20 bomb. Tasks evaluated using the camera included such things as weapons hanging, maintenance of the Martin Baker seat, a trial installation of a devlopment stage missile, and technical order validation. Because the F-4 is an aircraft that has undergone a number of model changes, it was considered a good system on which to probe the limitations and uses a press camera with a Polaroid back as a PSTE tool. Thus, design and procedure change recommendations could be incorporated into later models. The video tape recording equipment was specially modified at the contractor's facility for portability and ease of operation required for efficient data gathering in the system test situation (which is characterized by a requirement for quick reaction). The principle investigator spent a total of four months at Edwards AFB (during this time traveling to Nellis AFB). The purpose was to record test situations that had implications for human

factors design, and to convince the various groups responsible for system testing and design (e.g., major air command, SPO, testing and contractor groups) of the value of the technique. Extensive field evaluation of the technique was accomplished because this was the only way to demonstrate that the technique was valuable for carrying out its intended purpose, and to probe the limits of its usefulness. A detailed procedure describing the particular configuration of the camera used in the research effort and procedures for its field use are contained in the appendix.

Results: The camera used in the study consisted of a 4" x 5" Crown Graphic Camera, a Polaroid Land Film Holder #500, a Western Master V Light Meter, and a Sampson Tripod. One film packet was inserted into the camera at a time. The photographic data obtained could be of one of three types: (1) black and white print, (2) black and white negative and print, or (3) color print. Potential applications of the camera in support of PSTE include the following: (1) It can be used to evaluate visual access problems (the camera can "see" what the individual sees from his working position). (2) A work envelope can be established for anthropometric evaluation by placing a string grid network between the camera and the subject. (3) The effect of parallax on reading displays can be established and the resulting error can be measured.

One of the uses of the technique probed in the study was its use in extracting data off of a television monitor when the monitor was showing the playback of a video tape recording. For example, this was done when a video tape recording was taken documenting the difficulties in removing a radar antenna because of the design of the bench and the lack of a special piece of aerospace ground equipment (AGE). Polaroid photographs of critical parts of this task aided in the analysis that determined difficulties in both design and procedure. Also, the Polaroid photographs aid in writing PSTE reports because they greatly simplify the problem of describing equipment. PSTE problems that are depicted by photographs are more effective in persuading responsible individuals to do something about the problem than is a verbal description of those same problems. The particular camera configuration used in this study produced photographs of good quality. The unique advantage of a Polaroid camera is that photographs can be examined on the spot and if the photograph is not adequate, another one may be taken. PSTE problems must be documented as they occur because frequently they do not occur again. Several improvements on the camera configuration are suggested in the full report.

Conclusions: The use of a Press camera with a Polaroid back as a method of assessing performance in the context of system testing has been demonstrated to have real potential. The configuration suggested in the full report is inexpensive and relatively easy to use and a camera like the one described should be made available to PSTE personnel at the test sites and at contractor facilities. A particular effort should be made to institute the human factors testing program as early in the system development process as is possible. This is the most cost-effective way systems can be well designed from a human factors standpoint.

This summary was prepared by J. Peter Kincaid, Personnel and Training Requirements Branch, Training Research Division, Air Force Human Resources Laboratory.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION I

INTRODUCTION

PROBLEM

Personnel Subsystem Test and Evaluation (PSTE) has been hampered by two problems: (1) PSTE equipment has not always been adequate, and (2) PSTE has sometimes been though of as an isolated element tacked onto the end of system development.

In part, the first problem is a carry-over from when human engineering was directed primarily toward air crew/cockpit evaluation. Problems, such as oxygen consumption, toxic gases, vertigo, and lighting were emphasized. Most test equipment was specialized and measured a specific substance or physical value.

With the advent of the total system concept, many of the techniques and equipment used for air crew/cockpit evaluations were retained and redirected toward maintenance. However, these methods do not provide the broad approach required for evaluating human performance in the system.

The inadequacies of currently used PSTE techniques are aggravated in most test situations because of understaffed PSTE teams and the great quantity of system personnel, equipment, and procedures to be evaluated.

In a well conceived and executed Personnel Subsystem (PS) program, PSTE should not be treated as an isolated element. Rather, PSTE should deal broadly with human engineering and life support, training and training equipment, qualitative and quantitative personnel requirement information, and personnel-equipment data. Even when the system is operational, the knowledge gained in these efforts is applied to Engineering Change Proposals (ECP's), later models, and new systems.

PSTE planning should concentrate on those systems, subsystems, and components most likely to cause problems when user personnel operate and maintain them. This basic problem-solution orientation requires quick and accurate identification of critical tasks.

PURPOSE

The purpose was to identify, develop, and assess new devices, instruments, and techniques for making PSTE more effective.

APPROACH

The approach consisted of:

a. Selection of two subsystems to validate new PSTE techniques.

b. Study of selected subsystems in areas where PSTE of ground operator and maintenance functions should be accomplished.

c. Evaluation of techniques and equipment that have potential for improving PSTE, and selection of the three most promising.

d. Development of selected techniques and equipment to make them fieldworthy.

e. Development of test guides for the techniques that specify the test criteria, step-by-step instructions, and data treatment.

f. Application of the techniques to the testing of two subsystems.

g. Assessment of the value of the techniques for PSTE and for evaluating early design.

h. Identification of the unique capabilities of the techniques.

i. Definition of further development needs for the techniques.

The details of the approach are to be found in Figure 1.

OVERVIEW

Experience with most past PSTE programs indicated that the overall requirements for PSTE, as defined in AFSCM 80-3, AFR 30-8, and AFR 80-14, exceed the capabilities of the PSTE staff. At the same time, most test personnel agree that PSTE should be more extensive than present requirements permit because personnel problems are so pervasive and critical for operational success.

In the past, the pilot/cockpit evaluation has received most of the PSTE teams' attention and effort. This is because of the pilot orientation of the test teams and because many areas related to mission success are aircrew functions. Maintenance, technical publications, AGE, maintenance training, and maintenance training equipment have not received adequate evaluation, perhaps because they are difficult to evaluate. Thus, only serious and obvious maintenance problems are reported, while many others are unreported or their causes poorly identified. This study was directed specifically to improve the ability of the PSTE team to isolate, identify, report, and solve maintenance problems.

PSTE is usually a reactive process, concentrating on areas where problems exist. This approach presumes that test personnel know beforehand what constitutes a PSTE problem and then concentrate their effort there. This approach has been moderately successful, and the results have been significant. However, it does not provide for the thorough, methodical wringing out of the system that is needed to complete the approach of engineering and other test disciplines. Results often verify a problem, but seldom identify one through analysis, especially unanticipated ones that can profoundly affect

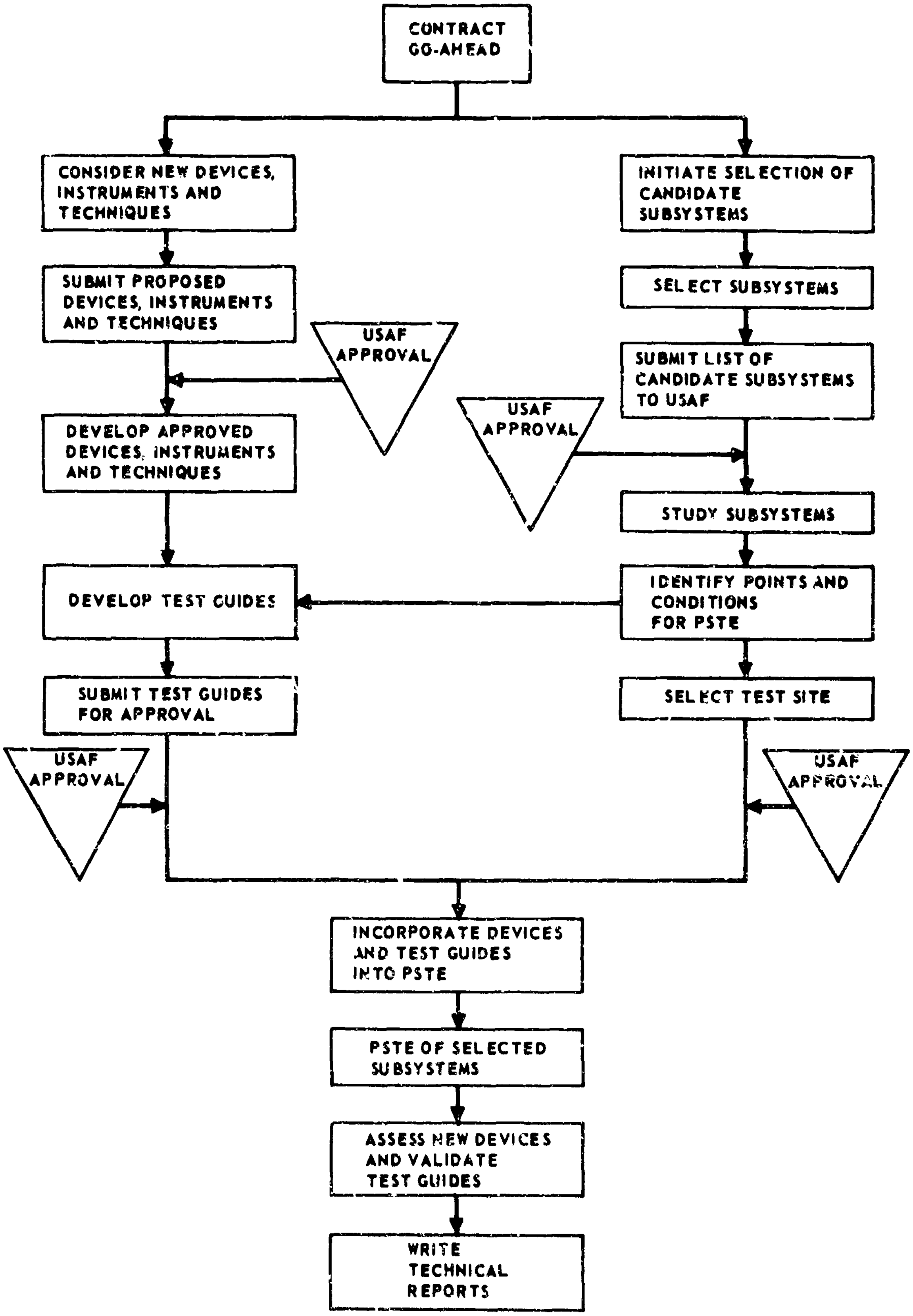


FIGURE 1 – THE TECHNICAL APPROACH USED IN THE STUDY

mission success. Procedures, equipment, and manning are accepted at face value with only token attempts to assess them for maximum effectiveness. PSTE has had growing pains. It has been better to achieve selective success than to evaluate the whole personnel subsystem and fail.

Field experience suggests an approach that provides more effective utilization of PSTE manpower and a more methodical and complete evaluation of PS elements. This is the development of better assessment techniques and their associated equipment and criteria.

Three techniques chosen were:

- miniature event recorder
- video tape recorder
- press camera with a Polaroid back

The press camera system is composed of:

- 4 in. x 5 in. press camera
- Polaroid film holder
- Light meter
- Tripod

The camera system is illustrated in Figure 2.

The camera system possesses several unique features aided in the implementation of PSTE:

- Imagery is ready for viewing in less than one minute after exposure.
- Relatively large format, 4 in. x 5 in., allows the evaluator to make notations on the print, and the print is large enough to be used in reports.
- Ground glass focusing provisions allow for precise focus, framing, and positioning.

Test guides were developed to implement the techniques based upon the field tryouts. These guides define the objectives, criteria, and procedures for field use of the technique.

Several trips were made to Air Force bases where F-4 tests were in progress. The new techniques were discussed in depth with test management personnel. Test directors showed great interest and all cooperate in implementing the techniques.

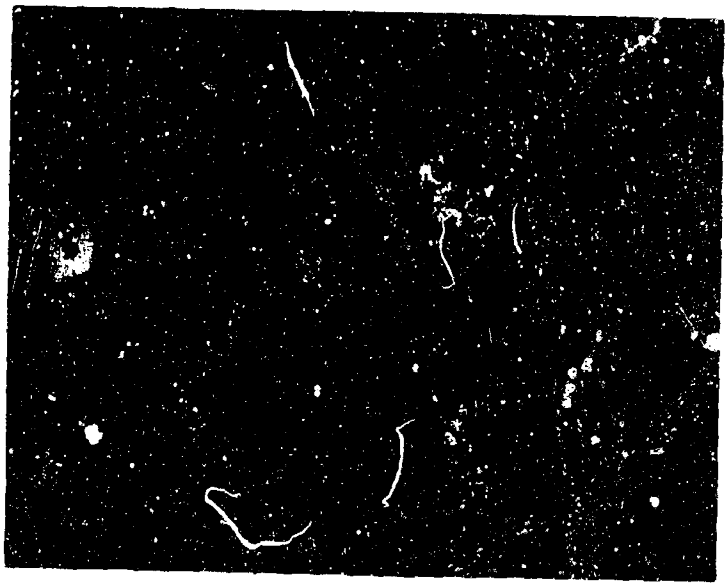


Figure 2. Press Camera System

The test site selected for implementing the study was the F-4E Category II test at Edwards AFB, California. The equipment was used there for four months beginning in mid-November 1968. It was used for the PSTE of the AN/APQ 120 radar, the Martin Baker Mark H7 ejection seat, and several other systems and subsystems.

The results are described in Section IV. The technique is assessed in Section V. The application of the camera technique to earlier design and phases of system design is also discussed.

SECTION II

METHODS

The selection of techniques and equipment, the development of field-worthy equipment, and the plans for applying the techniques are described here.

SELECTION OF TECHNIQUES

The wide variety of off-the-shelf equipment requires selecting the most appropriate equipment using these criteria:

Will Objectively Measure Human Performance

Human performance assessment is essential to PSTE just as equipment performance measurements are essential to engineering. PSTE test conditions do not permit the control over measures possible in the laboratory. For example, measuring instruments cannot be attached directly to maintenance personnel. However, the techniques must provide data in terms of time, distance, anthropometry, and task difficulty.

Will Provide Data Useful for the System Test as a Whole

Data collected for PSTE is important to other test activities. The interpretation of results may require multi-disciplinary interpretation. Thus, PSTE data must be in a form readily applicable to other efforts.

Will be Usable on all Test Activities

In addition to slowing down the maintenance effort, interference can lead to invalid information. The techniques should not require special scheduling of maintenance tasks which interrupt normal work.

Will Have Application to Many Subsystems

Equipment may be useful for specialized hardware and human performance areas but does not have broad applicabilities. Much specialized equipment becomes too cumbersome and expensive for field use.

Will not Require Extensive Training to Use

Techniques should not call for a high skill level, or for an abnormal amount of prior knowledge.

Will Generate Data in a Form Readily Usable by SPO's, Contractors, and the Using Command

Communication between the test site and all interfacing military and contractor groups is a problem. The data should aid in the understanding

of the problems directly without interpretation by experts. Any method that would speed and enhance understanding would receive special attention.

Will Have a Fast Reaction Capability

Because testing is geared to a schedule, maintenance tasks are performed as soon as practicable. Most maintenance is based on unanticipated failures. PSTE equipment that requires extensive hook-up time, calibration, and preparation would not be practical.

Will Provide Operationally Significant Results

Techniques that can identify the relationship of the task to launch time, turn-around time, operational ready status, and ordnance uploading and down-loading should be given special consideration.

SELECTION OF TEST SITE

The selected PSTE techniques were to be developed and validated by use in an ongoing system test. McDonnell Douglas has implemented the PS programs on the F-4 aircraft. The F-4E aircraft was in Category I, II, and III testing during this study.

F-4E testing was being carried on at three locations:

- Category I test at the MDC Facility at Edwards AFB.
- Category II test by a joint AFSC and Tactical Air Command test team at Edwards AFB.
- Category III, primarily Tactical Air Command, was at Nellis AFB and Eglin AFB. Several trips had been made to each of these bases by the Principal Investigator. Additional trips were made to discuss study objectives, scope, and requirements. Test management was interested in the proposed techniques, and understood the difficulties in evaluating maintenance. They were especially helpful in identifying the applicable tests.

Test site selection was based on the following assessments:

a. Edwards AFB, F-4E Aircraft Category II Test.

This F-4E was in its second year of testing. A formal PSTE program was being implemented by a team composed of AFSC officers, Air Training Command Non Commissioned Officers, and contractor personnel, including a PSTE representative from MDC. Because the test team was familiar with PSTE, indoctrination was not required. Because the tests were also primarily verifying performance, new PSTE techeniques would not create concern. In

addition, the F-4E Category I test was being conducted at the MDC Facility at Edwards AFB and might aid evaluation of activity at an earlier stage of equipment development.

Unfortunately, only two F-4E aircraft were in system test, and one of these did not have a radar subsystem. Thus, the maintenance volume was quite low. It also was being performed by AFSC, TAC, contractor, and vendor personnel who are not representative of an operational unit. Training, training equipment, and QQPRI were not examined because F-4E training was not being conducted. Also, the logistic supply situation was not typical.

b. Eglin AFB, F-4E Aircraft Category III Test

The Category III testing on the F-4E was ending as this study began, but operational testing was scheduled to continue during the study period in a series of 'follow on' tests. The 33rd Tactical Fighter Wing of F-4E's was based at Eglin AFB and in training. Because of the large volume of maintenance, maintenance personnel, and the use of operational procedures, this site offered the most realistic operational environment short of Southeast Asia.

The 33rd Tactical Fighter Wing was preparing for deployment, accelerating certain maintenance functions. Injecting untried PSTE techniques into a stressful situation could create resentment. Since PSTE was not being implemented, there was no established work base nor provisions for reporting results.

c. Nellis AFB, F-4E Aircraft Category III Test.

This site also was being used for F-4E Category III tests in coordination with Eglin AFB. There was a greater volume of maintenance activity here than at Edwards AFB, but less than that at Eglin AFB. Nellis did not have a PSTE effort and F-4E training and training equipment was not on site.

The following recommendations were made regarding test site selection:

(1) Category II test on the F-4E at Edwards AFB would continue for several months and afford a sound basis for equipment evaluation under testing conditions.

(2) F-4E Category II test personnel at Edwards AFB concurred that this study would be useful to their effort and that they would cooperate.

(3) The MDC Edwards AFB Facility offered additional potential with its F-4E Category I effort, and F-4C/D/J/K/M and RF-4C/B testing.

(4) The Directorate of Material at Edwards AFB was interested in this study, and would cooperate in its implementation. The Directorate would provide for evaluation of aircraft and subsystems over a wide range of maintenance and would allow interfaces directly with the Base Commander.

(5) Nellis AFB was near enough to Edwards AFB (260 miles) to allow some evaluation under Category III conditions.

(6) Developmental problems with the PSTE test equipment would interfere with the rapid pace at Eglin AFB. These problems would be solved as part of the study, but they could degrade operational maintenance.

Edwards AFB was approved as the evaluation site by the contract technical monitor.

SELECTION OF SUBSYSTEMS

The applicability of study results to other aerospace systems, including aircraft, spacecraft, missiles, and command and control systems must be considered in selecting subsystems for evaluation. Therefore, subsystems should meet most of the cirteria in Table I.

TABLE I SUBSYSTEM SELECTION CRITERIA

1. BE SUFFICIENTLY COMPLEX TO WARRANT EVALUATION (STRUCTURE, ELECTRONIC, HYDRAULIC, PNEUMATIC).
2. REQUIRE DIAGNOSIS OF MALFUNCTION AND REPAIR BEYOND SIMPLE STRUCTURAL FAILURE OR THE OBVIOUS MALFUNCTIONS.
3. REQUIRE AGE FOR MAINTENANCE.
4. HAVE A RELATIVELY HIGH RATE OF FAILURE AND/OR FREQUENT ADJUSTMENTS, AND/OR SERVICING FOR OXYGEN, HYDRAULIC FLUID, AMMUNITION OR FUEL.
5. REQUIRE BOTH FIELD AND ORGANIZATIONAL MAINTENANCE.
6. BE COMPATIBLE WITH SECURITY REGULATIONS SO THAT RESULTS CAN BE PUBLISHED OPENLY.

Two subsystems that best met the criteria in Table I were the AN/APQ 120 radar and the Martin Baker Mark H7 ejection seat. The AN/APQ 120 radar has classified elements but which could be avoided in reporting study results.

a. AN/APQ 120 Radar.

This radar is one of the most advanced fire control systems in the Air Force inventory, was scheduled for Category II test at Edwards AFB until April 1969. The complexity of the equipment, its importance for the mission, and extensive AGE provided a comprehensive base for evaluating the new PSTE techniques and equipment in human engineering, training, and manning areas.

b. Martin Baker Mark H7 Rocket Ejection Seat.

This seat replaced the Mark 5 seat which uses gun action alone. Propelled by gun and rocket power, it provides a zero ground, zero altitude ejection capability. It was not scheduled for formal Category I, II, or III aircraft. Earlier human engineering evaluation had identified maintenance

tasks involving servicing of pyrotechnic devices and many mechanical mechanisms. This subsystem completed the electronic characteristics of the AN/APQ 120 Radar.

The AVE and AGE for the two subsystems are listed in Tables II through IV.

IDENTIFICATION OF POINTS AND CONDITIONS FOR PSTE

The identification of major points and conditions for PSTE was guided by the primary requirement that PSTE should provide for the PS elements. A secondary requirement was that PSTE should provide for assessing of basic human performance to include learning, motor skills, perception, group behavior, precision of movement, and task performance.

The McDonnell Douglas F-4 PS participated in developing the AN/APQ 120 radar and the Martin Baker Mark H7 ejection seat. This resulted in inputs to AVE, AGE, technical publications, and training. Later in development, PS personnel were involved in Category I, II, and III testing of these subsystems. Table V shows the PS interfaces with development used to identify the points that required further evaluation.

Timing is important for conducting PSTE on maintenance tasks. Except for periodic maintenance and inspections, maintenance is only performed when malfunctions occur or when special testing changes are made. The reporting of malfunctions is processed through work load control. Appropriate personnel and shops are assigned to rectify the problem.

The method of selecting the task for study depended on:

a. Priority of PSTE evaluation.

b. Association of task with one of the two study subsystems.

c. Potential criticality of task.

These considerations did not preclude the use of the camera for other test functions, such as pilot/cockpit evaluation, or being used to document damage or equipment configurations.

The organization of the F-4E test team is shown in Figure 3. The detailed organization of the maintenance section is shown in Figure 4.

The location and time of occurrence of maintenance varied widely. Principal locations were flight line, hangar, shop, hot line, and gun butt range. Maintenance could occur at anytime in any 24 hour period, depending on its criticality. Nighttime, flight line, hot line, and gun butt range presented the most difficult environments for PSTE. However, the environmental effects on task performance have been significant on PSTE consideration.

TABLE II AN/APQ 120 FIRE CONTROL SYSTEM AIRBORNE EQUIPMENT

Part No.	
53-870050-21	Antenna
-25	CW Transmitter
-45	Stabilization Assembly
-47	Cable Assembly
-49	Pump Tube Power Supply
-43	Support Structure
-33	Servo Assembly
-35	Microwave Assembly
-37	RT Electronics
-39	Stalo, Pulse
-41	CW Electronic
-23	Computer
-27	Power Supply
-29	Pulse Transmitter
-31	Synchronizer
53-870050-3	Radar Set Control
-5	Radar Test Set Control
-7	Antenna Control
-9	Indicator Control Unit
-11	Pilot Indicator
-13	PSO Indicator
-15	Mount, Pilot Indicator
-17	Dehydrator

TABLE III AN/APQ 120 AGE (ORGANIZATIONAL-FIELD)

ORGANIZATIONAL AGE

Part No.	
53E340008-1*	Missile Control System Test Set
-7	Accessories Kit
-13	MCSTS Truck
-17	Dehydrator Compressor
-19	Control Monitor
AN/APM-84B	Radar Modulation Test Set
TS-2059/AWM-18	RF Power Test Set
CN-808/A	Voltage Regulator
HD-416A/U	Hydraulic Pumping Unit
486991-110	Missile Interface Test Set
ME-6D/U	Electronic Multimeter
AN/PSM-6	Multimeter
AN/USM-105A	Oscilloscope
803B/AF	Differential Voltmeter
53E340018-1	Extender Bar Slide Rail
53E340013-1	Radar Test Set
53E340014-1	Computer Test Set
53E340015-1	Supplemental Kit
53E150185-1	LCOSS Test Set AN/ASM-238

FIELD AGE

53E34009-1*	Missile Control System Test Bench Set**
-3	Console #1
-5	Console #2
-11	Console #3
-17	Console #4
-19	Console #5
-21	Console #6

* Comprises A Composite Test Facility, Unique and Common AGE
** Some of the organizational AGE is used with bench.

TABLE IV MARTIN BAKER MARK H7 SEAT AND AGE

AVE

Part No.	Description
53-820000-1	Rocket Seat Assembly (Pilots Seat)
53-820000-3	Rocket Seat Assembly (PSO's Seat)

AGE

Part No.	Description	Maintenance Level O=Organizational F=Field
32E110077-1	Insertion Device - Strap Fittings	OF
32E110012-1	Insert - Safety, Firing Mechanism	OF
32E110013-1	Adapter Assembly - Ejection Seat Cradle	F
32E110014-1	Alignment Kit - Rocket Nozzle	OF
32E110026-1	Guard - Rocket, Seat Bucket	F
MDE 32365	Canopy and Seat Ejection Mechanism Tester Assembly	OF
MBEU 1925 RU	Torque Wrench	OF
MBEU 1730	Crow's-Foot Wrench	F

TABLE V PSTE INTERFACES WITH SYSTEM DEVELOPMENT PRODUCTS

<u>System Concept, Design, and Development</u> System Analysis Detailed Specification Vendor Proposals Contractual Data Requirements Specification Control Drawings (SCD's) Preliminary Drawings Final Drawings and Drawing Release Engineering Change Proposals (ECP's) Mock-up Reviews Aerospace Ground Equipment Recommendation Data (AGERD's) Simulation Data Delivery Schedules Prototype Equipment Production Equipment Technical Coordination Meetings <u>System Support</u> Maintenance Concept Maintenance Evaluation and Report Documents (MEAR's) AGE Conferences Reliability Data Facility Requirements Integrated Logistic Support Management Plans (ILSMP) <u>System Test</u> Acceptance Test Procedures Acceptance Testing First Article Demonstration Contract Technical Compliance Inspection (CTCI) Flight Test Reports Category I, II, and III Testing Personnel Subsystem Test & Evaluation (FSTE) Special Tests	<u>Standards, Specifications, and Design Criteria</u> Military Standards Military Specifications Air Force Manuals MDC Engineering Procedures Human Engineering Criteria <u>Manning</u> QQPRI Conferences QQPRI Documents QQPRI Field Verification <u>Technical Orders (T.O.'s)</u> T.O. Validation Demonstrations T.O. Verification Demonstrations Preliminary Technical Orders <u>Training</u> Training Program Conferences QQPRI Conferences QQPRI Documents Training Plans Training Texts <u>Training Equipment</u> Trainer Drawings Training Equipment Conferences Trainer Acceptance Conference <u>Field Data</u> Unsatisfactory Reports Accident Reports Maintenance Reports

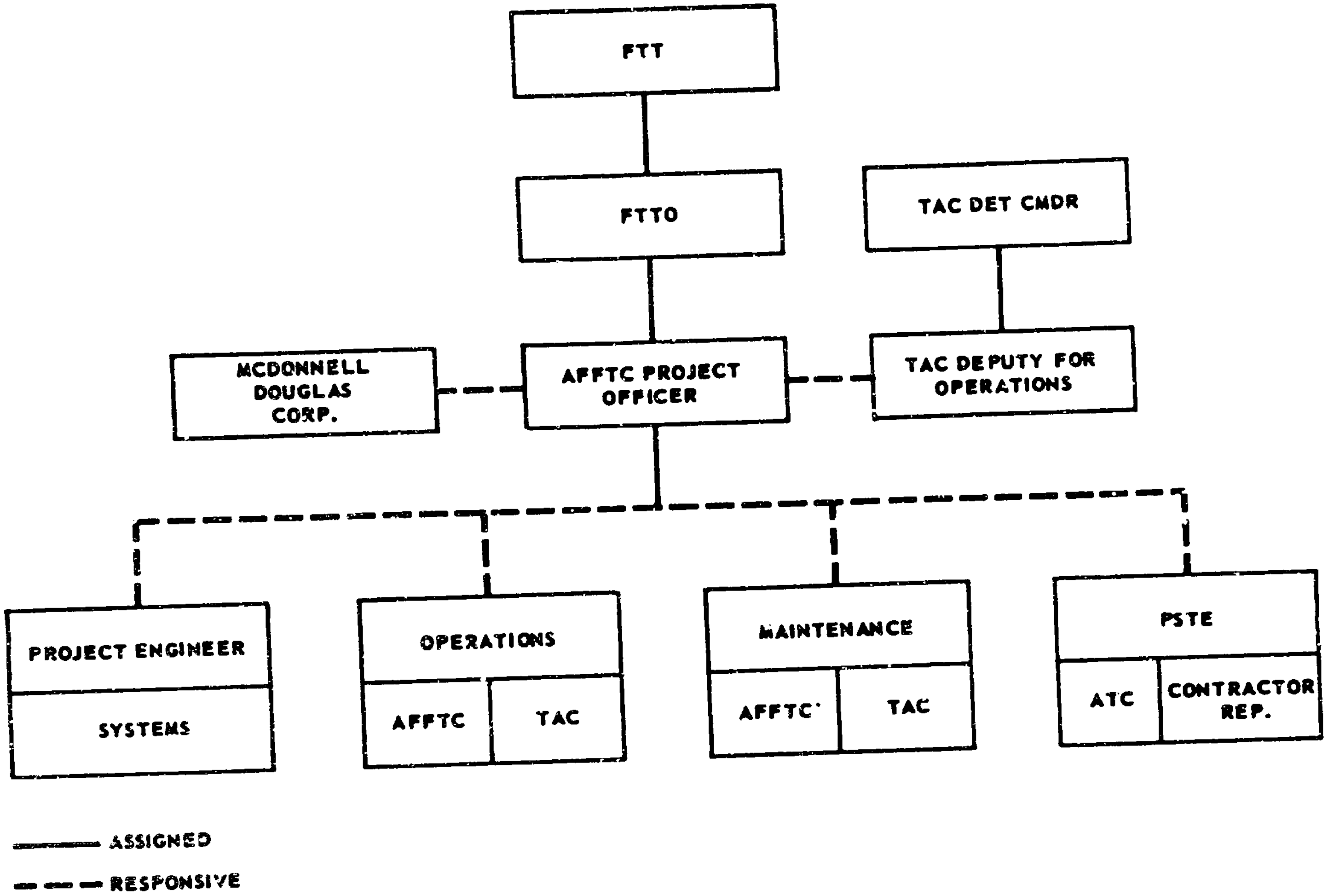


Figure 3. F-4E Category II Test Team Structure

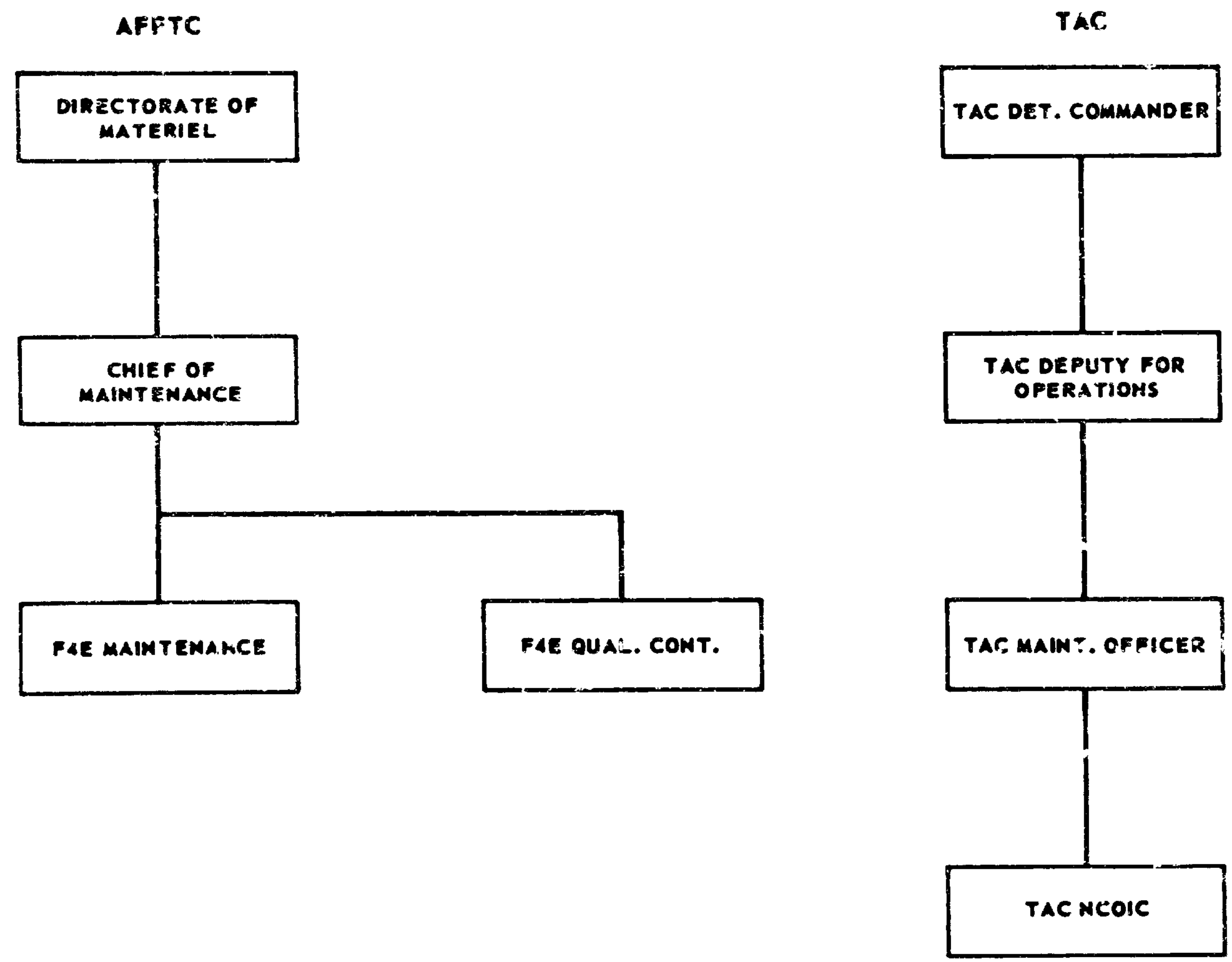


Figure 4. F-4E Category II Maintenance Structure

The following are potential applications of the camera technique in support of PSTE:

- Problems involving visual access can be graphically described by placing the camera so that it would "see" what the individual sees from his working position.

- The effect of parallax on reading displays can be determined and the resulting error could be measured.

- A work envelope can be established for certain tasks by placing a string grid system between the camera and subject. This technique can be further refined by placing lights on body points and taking a time exposure.

- The adequacy of tools can be determined through close-up photography. The suitability of tools depends on fit with the fasteners or connectors, the effect of the torque, and the limits of rotation. The camera can also be used to record tool-caused damage, such as burring or abrasion.

- The camera can be used to document damage or injury caused by accidents or equipment failure. Cuts, blisters, burns, or allergies can be recorded.

- Table top or full-scale models can be photographed in various configurations describing more effective equipment layout and design.

In addition, routine PSTE observation and evaluation can be supplemented with the camera system. PSTE personnel must obtain rapid results in data acquisition. The results from using Polaroid film allow the equipment to be returned to service quickly. The photographic data accelerates interaction with other test force sections by serving as a basis for inquiry and discussion.

PREPARATION FOR PERFORMING PSTE

PSTE requires the evaluator to be familiar with the task. For example, the loading of most ordnance follows a pattern in sequencing, tools, and AGE, and involves the same number of people in the load crew. If the evaluator knows these generalities, he can adequately evaluate a procedure for a new missile, bomb, or pod hanging. Maintenance on electronics, hydraulics, airframe, and other subsystems has general patterns that are characteristic to each subsystem. Sources of pertinent information are:

a. Personnel.

PSTE team members can instruct inexperienced individuals 'on site' as to critical tasks that are likely to occur in maintenance. These individuals can be given general orientation on the PS effort, equipment descriptions,

and basic PSTE responsibilities and techniques. In early testing phases, such personnel can observe specific tasks when they can be instructed in detail as to what can be expected. Later, they observe and evaluate maintenance activities with limited direction. Their reports should be reviewed by experienced human factors personnel prior to inclusion in the test report.

b. Technical Order Review.

A review of the task described in the technical order is desirable in interpreting the procedures. The technical orders are also used to determine adherence to or departure from procedures, identification of T. O. errors, and as a basis for improving procedures.

c. Critical Task Data.

Marginal task areas identified in early design should be followed during test since change of environment, personnel, frequency of use, or design can cause them to become serious problem areas. With prior knowledge of these suspected areas, one can select the techniques with which to test for criticality.

d. Observation.

Frequently, it is desirable to observe a task being performed before attempting an evaluati ... The specific area requiring data can be determined for a more effective effort.

e. Liaison With Test Sections.

During the course of this study, PSTE investigations were made upon information contained in casual remarks by test personnel.

SECTION III

EQUIPMENT

GENERAL

The camera system consisted of a 4 in. x 5 in. Crown Graphic Camera, a Polaroid Land Film Holder #500, a Weston Master V Light Meter, and a Sampson Tripod. The camera system assembly and operation will be found in Appendix I.

4 IN. X 5 IN. CROWN GRAPHIC CAMERA

The camera used, eight years old but in excellent condition, was equipped with a Kalart coupled rangefinder, a Graph Lock back, a Graflex Optar f/4.7 lens and a Graphex shutter.

The Crown Graphic, widely used by newspaper photographers is standard equipment at Air Force Base photography shops. Recently, some base photography shops have converted to smaller, lightweight cameras. This should result in more Crown Graphic cameras becoming available for PSTE purposes.

The Crown Graphic Camera possesses several distinct features.

a. Large Image Size - The 4 in. x 5 in. image area provides for adequate detail without enlargement in most cases.

b. Ground Glass Focusing - Permits through-the-lens viewing, framing, and focusing. A fresnel lens improves the intensity of the image on the ground glass.

c. Double Extension Bellows - The lens to film distance can be increased to twice the focal length of the lens yielding a full-size image of the object (1:1 ratio).

d. Internally Coupled Rangefinder - The rangefinder allows the operator to precisely focus the object from four feet to infinity.

e. Accepts a Wide Variety of Film Types - With accessories, this camera will accept sheet, pack, roll, and Polaroid film and glass plates.

The Crown Graphic Camera is versatile and has precision adjustment. The adjustments for framing, focus, and image size can only be performed with a camera that allows ground glass focusing. In addition, this camera can use Polaroid 4 in. x 5 in. land film packets.

POLAROID LAND FILM HOLDER #500

This holder adapts the Crown Graphic Camera to the 4 in. x 5 in. Land film packet shown in Figure 5. All of the packets feature imagery in one

Figure 5. Polaroid Land Film Holder #500

minute or less. The photographic data can be in black and white print, black and white negative and print, or color print. The holder can be inserted or withdrawn from the camera at will. Since the holder will accept one packet at a time, the operator can change the film without exposing a roll or change the film holders.

WESTON MASTER V LIGHT METER

Since the Polaroid land films range in speed from ASA 50 to ASA 3000 daylight, a light meter is essential. This meter reads directly in foot candles and has a double scale, one for strong light levels, and one for low light levels. These scales change automatically when the light baffle is moved over or away from the photo cell.

SAMPSON TRIPOD

The Sampson Model 7301 tripod is a heavy duty unit extending to 72 ins. and is equipped with a pan head and elevator mechanism. The tripod, also used with the video tape recording system, is essential for photographic data requiring accurate positioning of the camera and exposures longer than 1/25 second.

POLAROID LAND FILM

There are five types of film available in the 4 in. x 5 in. packets. Each has its advantages and limitations.

a. Type 57, Black and White Print, 3000-3200 ASA - This extremely high speed film can reproduce an adequate record with subject illuminated with as little as 2 or 3 foot candles with shutter speeds as fast as 1/25 second. It is so sensitive that it cannot be used in sunlight with the smallest aperture and fastest shutter speed. The prints are somewhat flat (reduced contrast). This film was the one primarily used in this study.

b. Type 52, Black and White Print, 400 ASA - This film is moderately fast and can create good prints with good contrast. Its lower speed makes it adaptable to outdoor photography. The picture quality is better than Type 57 because it will reproduce much better in the printing process.

c. Type 55 P/N, Black and White Negative and Print, 50 ASA - This packet provides a print for checking exposure, focus, framing, and content. The negative can be used for enlargements and multiple prints.

d. Type 51, Black and White Print of High Contrast, 200 ASA - This specialized film is for use where the image is to be in black and white with no intermediate gray tones. For PSTE purposes, it would be limited. The film could be used to render paper records or displays to show markings more clearly by reducing the shadings to either black or white.

e. Type 58, Color Print, 75 ASA - The need for color photographs in PSTE is limited. However, in some cases where color differentiates essential elements, or where injury to the body is encountered, it would be useful.

SECTION IV

RESULTS

The results of using the press camera with the Polaroid back on the AN/APQ 120 radar, the Martin Baker Mark H7 ejection seat, the engine inlet duct, high torque screw tools, and AGM 65A missile are presented here.

The use of the camera system involved access to classified areas, and the recording of classified material and required a base photographer's pass for the author. The total field testing time remaining after preparation was 60 working days.

The Category II test was in its second year of testing. Most of the significant problems with the F-4E aircraft had been reported in the F-4E progress reports. It was felt that simulation of problems already remedied just to make photographs would not be worthwhile. Several factors severely restricted the evaluation of the subsystems. One was weather conditions. Frequent rains, heavy winds, and cloud cover restricted the test flights and minimized maintenance activity. It was not that the aircraft could not take off, but testing usually requires good conditions for assessing the results of the test, and for ensuring that the various test parameters have been met. Secondly, the radar subsystem had undergone a series of changes and was performing much better than had been anticipated. The radar did not fail during field assessment phase.

Maintenance on the Martin Baker ejection seat was similarly reduced. Removals to allow access to other subsystems was the only activity involving the Martin Baker seat.

The effects of the reduction of maintenance on the two selected subsystems was partially offset by a series of demonstrations and tests on other equipment in earlier stages of development.

The PSTE team that originally manned the F-4 Category II test was reduced to five persons when the field phase started, and was further reduced to one person, the contractor PSTE representative, shortly thereafter. Other team members were transferred to other test programs. The ATC personnel, formally part of the F-4E test, returned periodically to work with the camera technique. Their knowledge of the subsystems, facilities, and maintenance schedule was an asset to this study.

The results of using the camera technique with the two selected study subsystems will be reported first. Results obtained in other tests will follow:

AN/APQ 120 RADAR

The technicians in the radar shop pointed out that the removal of the radar antenna was complicated by the design of the bench and by the lack of a

special piece of AGE. The radar antenna weighing 42 pounds, is removed so that a malfunctioning or suspect antenna can be checked out with the balance of the subsystem. An extender, bar slide rail, is used on the aircraft to extend the radar package forward for accessibility. The radar bench was not provided with this bar so that technicians must assume awkward positions to perform this task. The bench structure beneath the antenna prevents the personnel from getting under the antenna. The removal requires two men - one on each side of the bench who support the weight with their arms extended. There also are several delicate components below the antenna that could be easily snagged or dented.

This task was recorded with the video tape recorder. A series of still photographs were made from the monitor screen to document the technicians' body positions. The radar antenna is a classified item and these pictures cannot be presented. However, it should be pointed out that still pictures taken of the monitor screen at critical points provide data for anthropometry, work space layout, and other measurements involving man and the equipment.

The contractor PSTE representative was asked to describe a field modification to the glare shield for the radar scope. The modification consisted of an additional rubber glare shield that the pilot systems operator could use to cut out the ambient light by placing his face against the open end. This structure had a sloping end with an area recessed to accept the bridge of the nose. The original glare shield and additional structure were removed from the aircraft and a series of photographs were made with Crown Graphic Camera. See Figures 6, 7, 8, and 9. Since the aircraft was in frequent use, data acquisition was limited. The report was written using the photographs as a guide.

Based on PSTE experience such a technique will find constant use in this type of application. The PSTE personnel are frequently faced with the task of describing equipment and man's association with it. To do an adequate evaluation and to write a precise report, he must have accurate information. He must determine part numbers, define locations, express relationships and conditions. Although he has access to drawings, T. O.'s, and other data, selective photography of equipment and tasks would significantly improve PSTE efficiency. The time saved by not having to return to the equipment for additional notes or sketches or making repeated observations of tasks justifies the technique.

MARTIN BAKER MARK H7 EJECTION SEAT

One of the modifications related to the Martin Baker H7 Ejection Seat was the installation of a seat sequencing system. This system ensures that the seats will eject separately with a short interval between them to prevent the rocket blasts from burning the aircrew. One element in the system is a sequence initiator. Two unsatisfactory reports were received stating that the initiator was found reversed in the lines. The two hose connections are identical allowing a match in both the correct and reversed positions. A proposed corrective measure was to locate the initiator in a bracket that

Figure 6. Side View Glare Shield Addition

Figure 7. Rear View Glare Shield Addition

would only allow the initiator to be mounted in the correct position. This bracket had a hole that would only allow the small end of the initiator to pass through it.

The F-4E personnel suspected that the bracket itself could be reversed. In order to determine whether this reversal could actually be accomplished, a mock-up of the bracket was made and an attempt was made to install the initiator in both positions. See Figures 10 and 11. And, it was found that the initiator could be reversed. A careful investigation was made as to what conditions might cause the bracket to be reversed.

The results indicated that the bracket would be installed on the aircraft structure and that this bracket would not be removed for the purpose of replacing the initiator. However, if the bracket is removed for some reason it is possible for it to be reinstalled backwards. This possibility was called to the attention of the Technical Data Department so that they could incorporate a warning note in the ejection seat T.O.

No problems were identified while evaluating the Martin Baker seat that were related to work space envelope. Figures 12, 13, and 14 depict the potential of documenting this type of problem by using a string grid. This gridwork was made by fabricating a wood framework and lacing a heavy cotton string at 3" intervals. The technician in this series is loosening a bolt on the drogue gun. Note that the first and third pictures in the series show ejection seat structure interference preventing full rotation of the wrench. The third not only shows interference but a point where the technician could injure his thumb. Note that the thumb is between the wrench handle and the metal rod.

The grid provides the evaluator with coordinates for establishing work envelopes and anthropometry of the task. Note that the position of the hand has changed between the first and second of the series.

A whole room can be made a grid with the four walls and ceiling depicting the actual work space. Photographs of a task being performed on equipment in the work space can be taken through any of the walls or down through the grid ceiling.

HIGH TORQUE SCREW DAMAGE

The contractor PSTE representative was investigating the cause of high torque screw head damage. Two types of tools were being used to remove and drive these screws. Due to the close tolerances and beveled slot, these tools must be in good condition or they will damage the screw heads by slipping out of the slot and shearing part of the screw head. Due to the high torque required to break-out the screw, a damaged head may prevent normal removal. The tools in Figure 15 show wear and should not be used. A copy of the picture was sent to the appropriate personnel at McDonnell Douglas along with an inquiry as to how screw damage could be prevented, and if these tools were considered appropriate.

Figure 8. Production Flare Shield and Addition (End View)

Figure 9. Production Glare Shield and Addition (Side View)

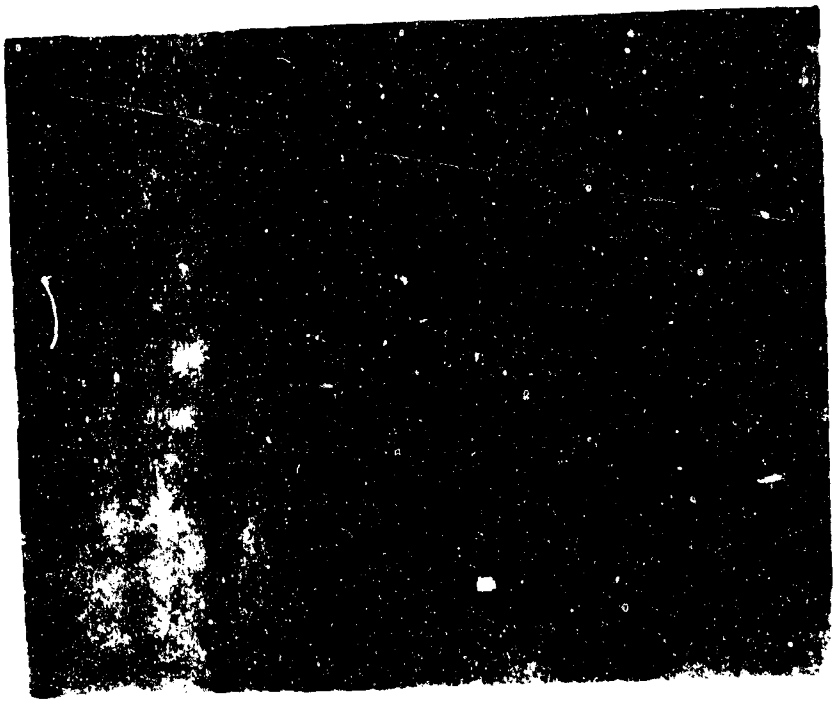


Figure 10. Incorrect Sequence Initiator Installation

Figure 11. Correct Sequence Initiator Installation

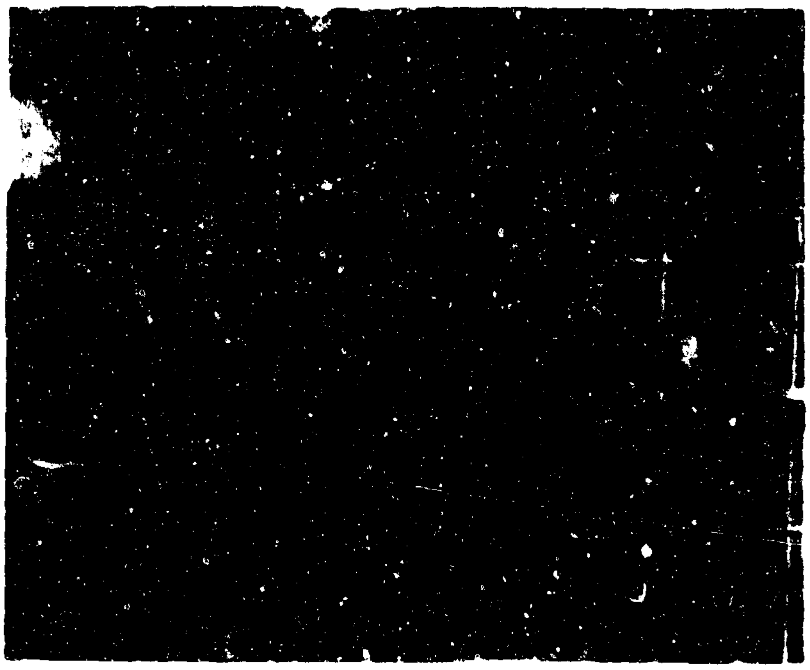


Figure 12. Wrench Rotation About Drogue Gun Nut Scene #1

Figure 13. Wrench Rotation About Drogue Gun Nut Scene #2

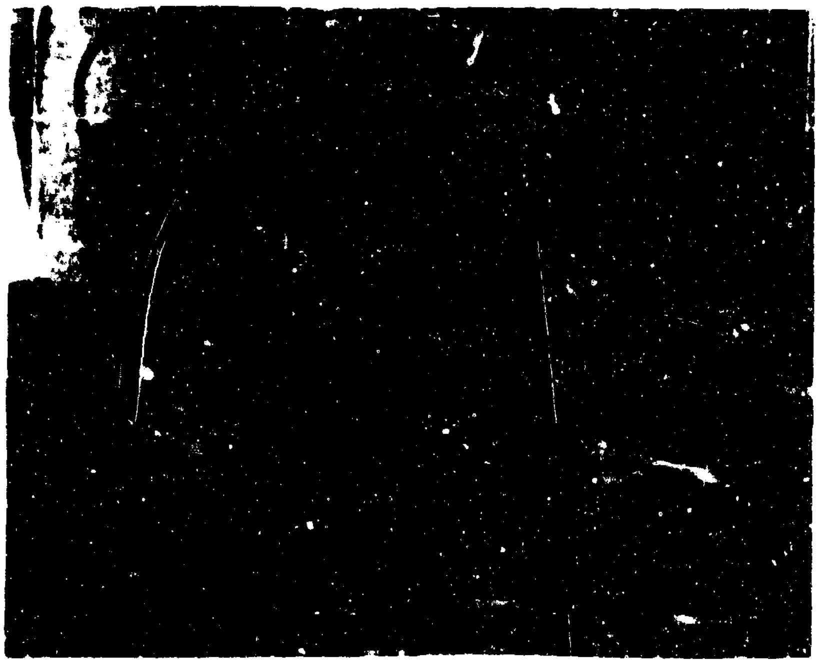


Figure 14. Wrench Rotation About Drogue Gun Nut Scene #3

ENGINE INLET DUCT

During flight the left hand engine inlet duct was damaged by a foreign object, as shown in Figure 16. The damage was such that the repair at the local level was questionable. The author was asked to take the picture so that it could be forwarded to the contractor facility for direction as to place and method of repair. Test personnel wanted to expedite the repair and wanted the letter out in the next mail. Ordinarily this would have been a base photography task, but because of the urgency the photo was taken with the study camera. This event is reported not as a PSTE example but to illustrate the speed with which testing problems are attacked.

MISSILE INSTALLATION TRIALS

The AGM65A Maverick missile was undergoing trial installations during the field phase. Extensive video tape recordings were made of these trials. As this final report was being prepared, persons involved with the AGM 65A/F-4 interface were reviewing the video tapes. They identified several areas primarily involving work envelope and clearances. They requested photographs of selected scenes so they could compare them to drawings. These pictures were classified and cannot be reproduced here.

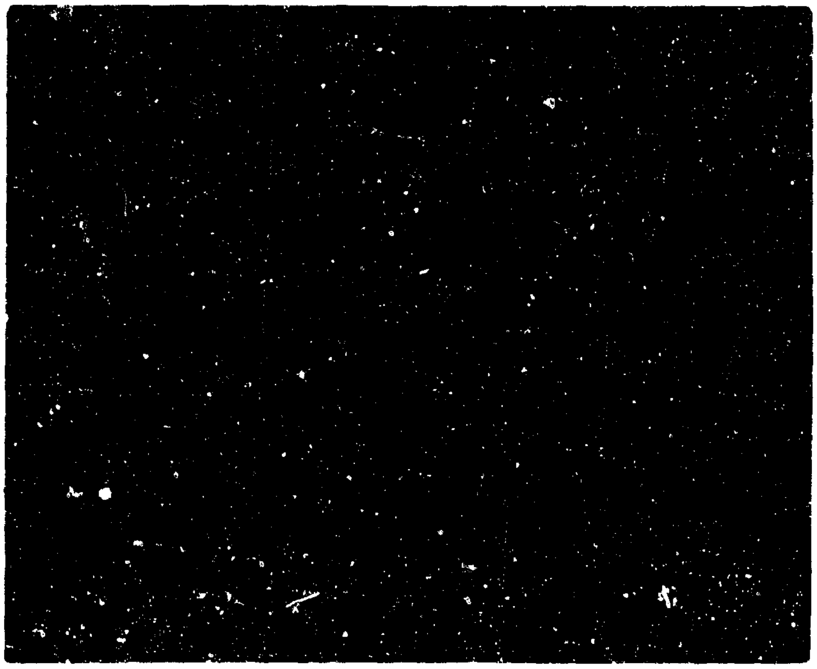


Figure 15. High Torque Tools

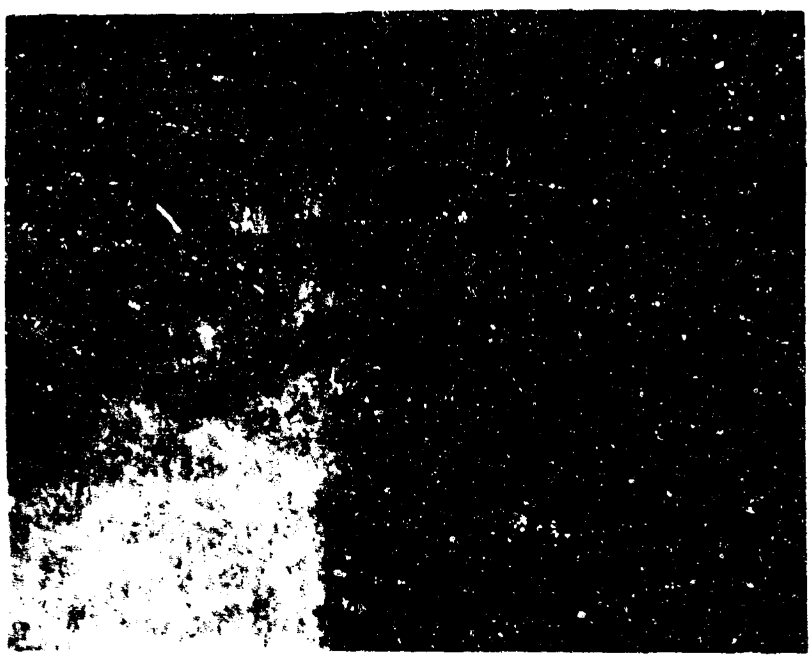


Figure 16. Engine Inlet Duct Damage

SECTION V

ASSESSMENT AND RECOMMENDATIONS

The utility of the press camera with the Polaroid back was recognized early in the field phase. Use of this technique stressed support of PSTE and minimized overlapping with base photography.

The primary application of this technique was in collecting data pertinent to specific human engineering problems. The pictures are used to check drawings as a means of communicating with other test sections and contractor personnel, and to preserve the event for analysis.

The contractor PSTE representative would have liked to have retained the camera for the duration of the test but previous commitments necessitated its return to the contractor facility.

Had the camera and its accessories been available throughout the F-4E Category II test, much time and effort would have been saved.

Because the field phase was relatively short, there was no effort to obtain base photographer passes for PSTE personnel.

ASSESSEMENT OF EQUIPMENT AND RECOMMENDATIONS

a. Press Camera

(1) Assessment

The Crown Graphic camera was versatile and performed well. Although the Graplex Optar f/4.7 lens is relatively slow, the fast Polaroid film negated the necessity for a faster lens. The camera was adequate for all objects and environment encountered.

(2) Recommendations

(a) The shutter and aperture controls on this camera require manual setting. It would be most economical to have a lens/shutter that would automatically adjust for brightness. At this time no such unit exists.

(b) The camera weights seven pounds. Some of the more recent press cameras are lighter and would be easier to manipulate. Cameras used for PSTE should be as light as possible.

(c) Extension tubes that would increase the lens-to-film distance would allow magnified images. These would be useful for tool/equipment analysis.

(d) There are situations where the operator cannot get in back of the camera to use the ground glass focusing panel. Photographing the cockpit from the pilot's eye position is

a frequent problem where the operator cannot use the ground glass. A periscope attachment on the lens would adapt the camera to limited areas.

(e) A locking case should be utilized to store the camera system.

b. Polaroid Land Film Holder

(1) Assessment

The film holder was adequate for PSTE. However, in the early phase of this study, the operator made several errors in inserting the packet and in processing. The resultant contamination and jamming required partial dismantling and cleaning of the holder. Another operator error was in inadvertently pressing on the camera while withdrawing the packet during processing, the uneven pressure resulting in part of the picture not being developed.

(2) Recommendation

An improved Polaroid film holder #545 with several improvements to reduce operator error should be used. For example, the load and process mechanism has been covered to prevent accidentally altering the spring tension of the processing rollers as the film packet is removed.

c. Light Meter

(1) Assessment

A light meter is an essential accessory to the camera system. Quick establishing of the proper exposure cuts film waste and reduces task. The sensitivity of the Weston Master V was adequate for ambient conditions encountered in this study.

(2) Recommendation

An adequate light meter should be used. The light meter should produce accurate readings as low as five foot candles. This permits making correct exposures under low ambient light conditions.

d. Tripod

(1) Assessement

A heavy duty tripod is required for imagery requiring accurate placement, framing, focusing, and registration. The Sampson Model 7301 tripod used was quite sturdy. The pan/tilt head was in the accurate placement and angle of the camera.

(2) Recommendations

(a) The camera requires a tripod for most PSTE applications.

(b) A tripod with an elevator mechanism is preferable. It reduces the need for adjusting the tripod legs.

(c) In order to permit photography from low angles, a device that attaches to the elevator head and lowers the pan head to near floor level should be acquired.

e. Film

(1) Assessment

All of the Polaroid land films offer rapid results. The characteristics of the films permit photography under a wide range of field conditions and subject matter. Flash bulbs and electronic flash units would not be required normally. The trials with color film (Type [illegible]) indicated that the exposure, ambient temperature, and processing time were much more critical than with the black and white film.

Cleanliness during the print coating operation requires special attention. Dust and dirt falling on the surface upon which the prints are being coated are picked up by the coater and deposited on the print surface.

SECTION VI

SUMMARY AND CONCLUSIONS

Use of the press camera with a Polaroid back is a valuable PSTE technique which was quickly accepted and utilized at the test site. The rapid acquisition of graphic data aids in the speed and accuracy of reporting.

The use of the camera technique will be summarized in terms of the original criteria.

Will Objectively Measure Human Performance

The camera technique enables the evaluator to obtain static views of maintenance activity. From the data the evaluator can establish many factors related to human performance, including work space envelope, visual access, anthropometry, and use of tools.

Provide Data That is Useful to a System Test Effort

Photographs taken with this camera were used for PSTE and other testing needs. A request was made for retaining the camera at the test site. Unfortunately, the camera was needed at the contractor's facility.

Can Be Used During Test Activities

The camera was used in hangar, flight line, and shop areas. The Type 57 film used was fast enough to work in even the dimmest light situations.

Will Produce Minimum Interference With Test Activities

The use of the camera resulted in minimum interference with maintenance activity. Close-up shots (macrophotographs) requiring a tripod and ground glass focusing take a few minutes longer than the normal shots.

Have a Potential of Being Frequently Used and Applicable to Many Sub-Systems

This versatile technique has wide application.

Will Be Based On the Technique as Being a PSTE Tool in Contrast to a Research and Development Tool

This technique is applicable to the testing and development of systems.

Can Be Used by Test Personnel Without Extensive Training

The ATC personnel, the contractor PSTE representative, and contractor PS personnel have learned how to use the camera system in an hour or two. Because the results can be promptly assessed, the operator learns the

correct procedures much more quickly. Elementary photography texts should be utilized by those who intend to utilize this technique extensively.

Will Generate Data That is Usable by SPO's, Contractors, and the Air Force Commands

The photographic data has universal application. Its use as a PSTE tool was primarily internal to PSTE. The resulting photographic data was used to develop reports.

Will Be Adaptable to a Fast Reaction Situation

The camera system is capable of being put into use within a few minutes. If this system were to become a standard PSTE tool, it would overcome a serious shortcoming in present conditions.

Will Provide Results That Have Operational Significance

Use of the camera permits obtaining details of tasks and equipment that create delays and cause damage to other equipment or injury to personnel.

A logical question might be asked: Why should the PSTE team be provided with a camera when the Air Force bases have photographers and well-equipped photo shops?

First, the use of cameras by PSTE personnel is not intended to substitute for base photography support of a test effort. The proposed concept is one of additional photographic data, not one of substitution. Perhaps the following rationale will differentiate between the functions of base photography and PSTE.

a. The PSTE team on the test site observes maintenance tasks. For their major portion, there is no need for a photographer. To have a photographer on standby would be inefficient.

b. In the field of human factors, particularly PSTE, the trained observer knows how best to describe the critical task. He may need photographs to aid in description. With the delay of conventional photographic processes, he may find that the pictures taken by another are inadequate and that it is impractical or too late to repeat the task. This factor has complicated PSTE reporting in the past.

c. The photographic data needed for PSTE frequently does not warrant the time and expense of base photography support because the material is usually used as reference.

d. Pictures required for reports normally should be taken by the base photographers. The high quality and precision needed for reproduction is strictly a base photography function.

e. Tasks that involve critical situations should be documented by the base photographers.

f. The PSTE team should have the capability of photographing unexpected events. Normally, there is not enough time to acquire base photography support.

The camera system was extensively used to provide data for the illustrations used in the three technique test guides. Most of the test guide illustrations were based upon Polaroid photographs. As an example as to the value of this technique, the illustrators were able to make most of the illustrations without any further direction or a need to see the equipment.

APPENDIX

CAMERA SET ASSEMBLY AND OPERATION

INTRODUCTION

This manual contains the procedures necessary to prepare and operate the Camera Set. The procedures consist of the following sections: Reference Publications; Precautions to be Observered; Preparation; and Operation.

The Reference Publications section lists the commercial manuals supporting the Camera Set.

The Precuations to be Observed section identifies various areas in the Camera Set that, under certain conditions, are subject to damage or may cause injury to personnel, and specifies the correct methods for avoidance.

The Preparation section provides assembly and adjustment instructions for the Camera Set prior to operation.

The Operation section contains procedures necessary to fully utilize the Camera Set.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS/TABLES

SECTION I

REFERENCE PUBLICATIONS

1-1. GENERAL.

1-2. The following is a list of publications supporting the Camera Set:

Morgen, Willard D., Lester, Henry M., Graphic Graflex Photography, Morgen & Lester, New York, New York, 1946.

SECTION II

PRECUATIONS TO BE OBSERVED

2-1. GENERAL.

2-2. The Precautions to be Observed section lists areas of the Camera Set that are subject to damage, and provides instructions on avoiding damage or injury to personnel.

2-3. FILM.

a. To prevent damaging the development reagent, do not press the pod of the unused film packet.

b. Use care to avoid contact with the brown, jelly-like developer that is exposed when the film packet is opened. The developer is caustic and causes alkali burns upon contact with skin. Keep the developer away from the vicinity of eyes and mouth. If developer contacts skin, wipe off immediately, then flush with water. Do not allow the developer to contact clothes or furniture.

SECTION III

PREPARATION

3-1. GENERAL.

3-2. Section III, Preparation, provides preliminary instructions on setting up the Camera Set for operation. The procedures consist of the following: Preparation of Camera; and Adjustment.

3-3. See Figure 3-1 for components comprising the Camera Set.

3-4. PREPARATION OF CAMERA.

3-5. MOUNTING CAMERA ON TRIPOD.

NOTE

Do not perform following procedure if Camera is to be hand-held for action shots.

a. Loosen lowest knurled knob on tripod and unfold tripod legs. Adjust legs to desired elevation.

b. Mount Camera on Tripod mount with back of Camera facing positioning handle on Tripod. Secure Camera with captive screw on Tripod mount.

3-6. OPENING/CLOSING CAMERA.

See Figure 3-2.

3-7. Opening.

a. (See Figure 3-2, Detail A) Press Bed Release Button (3) (under leather) on Camera (2) and lower camera bed (1) until braces (5) lock.

RESULT: Click is heard and bed is locked in place, in line with bottom of Camera.

b. Rotate clamp (6) to forward position, loosening front standard (4).

c. Grasp loop on clamp (6) and pull front standard (4) to stops (9).

d. Rotate clamp (6) to right, locking front standard (4) in place.

3-8. Closing.

a. (See Figure 3-2, Detail A). Adjust focus control (10) until infinity markers are aligned on camera bed scale (7) and sliding track scale (8).

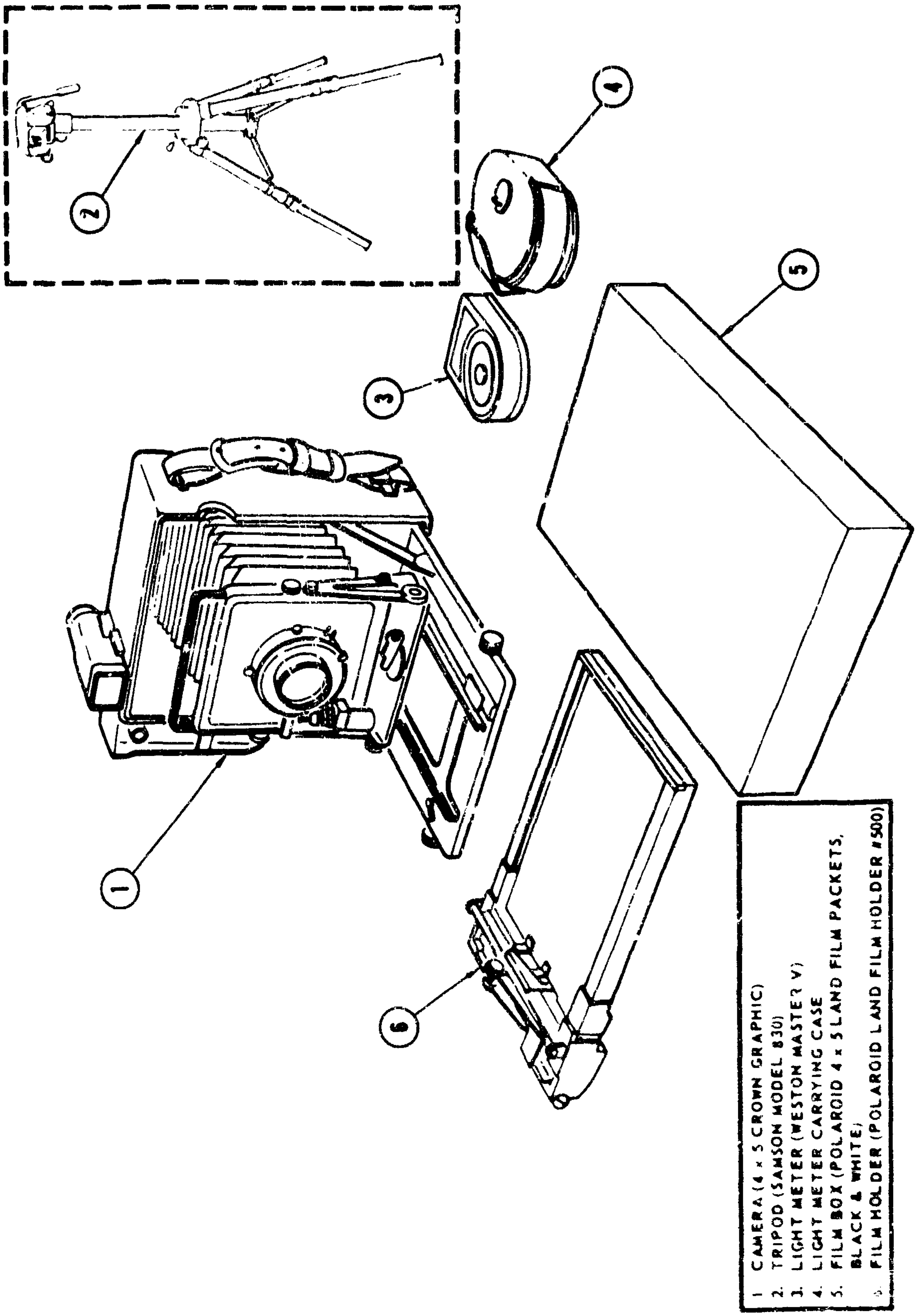
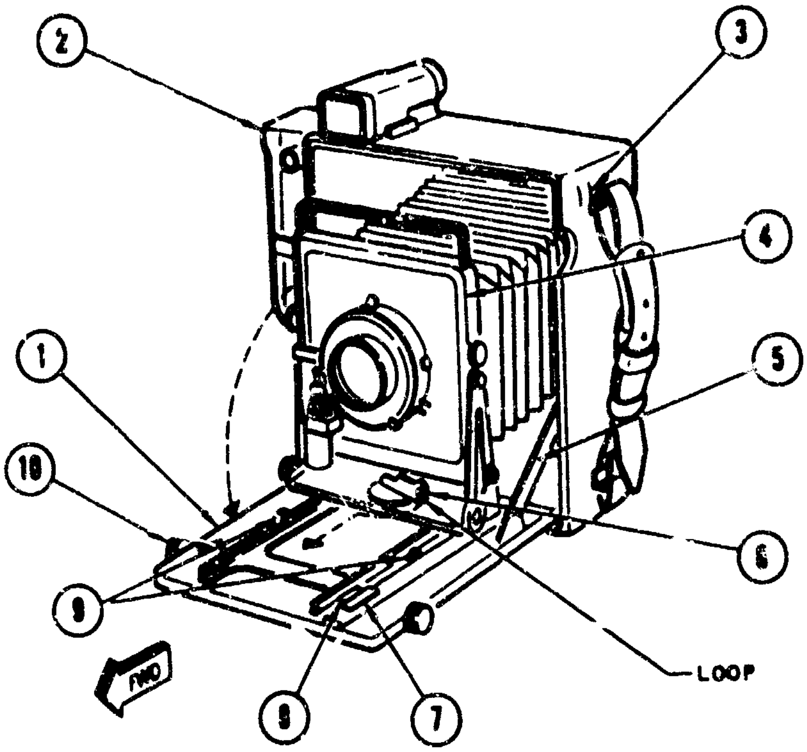
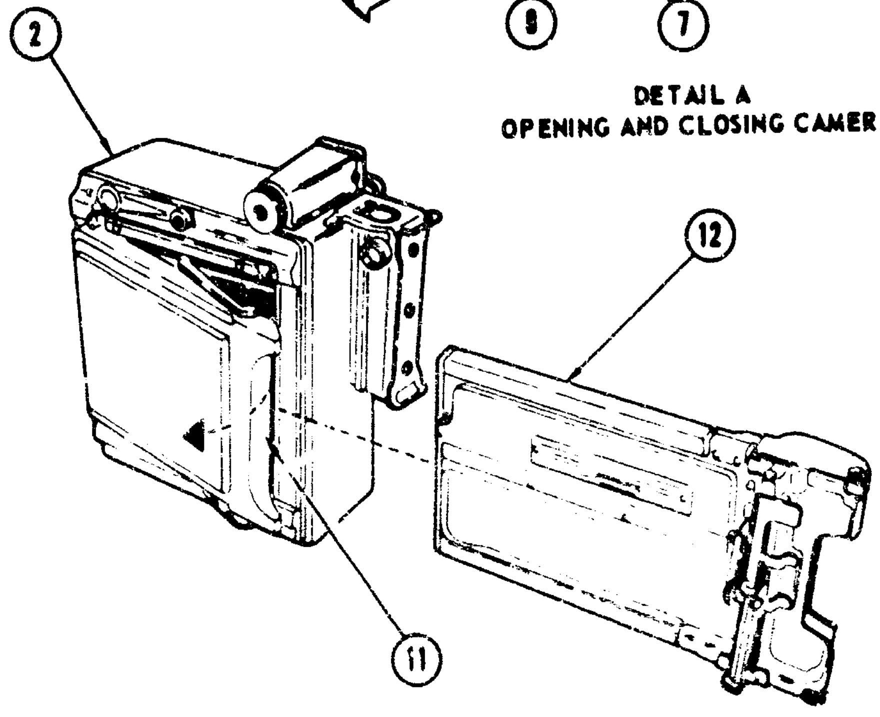


FIGURE 3-1. CAMERA SET

1. CAMERA BED
2. CAMERA
3. BED RELEASE BUTTON
4. FRONT STANDARD
5. BRACES (2)
6. CLAMP
7. CAMERA BED SCALE
8. SLIDING TRACK SCALE
9. STOPS
10. FOCUS CONTROL
11. FOCUSING PANEL
12. FILM HOLDER



DETAIL A
OPENING AND CLOSING CAMERA



DETAIL B
FILM HOLDER REMOVAL
AND INSTALLATION

FIGURE 3-2. CAMERA PREPARATION

b. Rotate clamp (6) to forward position, loosening front standard (4).

c. Grasp loop on clamp (6) and push front standard (4) into Camera (2).

d. Push braces (5) in and down, and slowly lift camera bed (1) up into Camera (2) until camera bed snaps closed.

3-9. FILM HOLDER REPLACEMENT.

See Figure 3-2.

NOTE

Film Holder normally remains in Camera except during ground glass focusing. Film is normally loaded and removed from Film Holder with Film Holder remaining in Camera.

3-10. Removal.

a. (See Figure 3-2, Detail B). Ensure film is not loaded in Film Holder (12).

b. Grasp Camera (2) and open right side of camera focusing panel (11) about one inch.

c. Pull Film Holder (12) to right until completely out of Camera (2). Allow focusing panel (11) to close against Camera.

3-11. Installation.

a. (See Figure 3-2, Detail B). Ensure film is not loaded in Film Holder (12).

b. Grasp Camera (2) and open right side of camera focusing panel (11) about one inch.

c. Insert Film Holder (12) a few inches into Camera (2) with black side facing forward (toward Camera lens). Release focusing panel (11).

d. Push Film Holder (12) left until holder stops and cannot be pulled out without opening focusing panel (11).

RESULT: Left edge of Film Holder is flush with left edge of focusing panel.

3-12. ADJUSTMENT.

3-13. FOCUSING CAMERA.

See Figure 3-3.

NOTE

> Three methods of focusing may be used: ground glass focusing; range finder focusing; or vernier scale focusing. Ground glass focusing should be used for precision focusing when the distance is unknown. Range finder focusing should be used for less precise focusing (action shots) when the distance is unknown. Vernier scale focusing should be used when the distance is known.

3-14. Ground Glass Focusing.

a. Mount Camera on Tripod. Refer to paragraph 3-5, Mounting Camera on Tripod.

b. Remove Film Holder from Camera. Refer to paragraph 3-10, Removal.

c. Open Camera. Refer to paragraph 3-7, Opening.

d. (See Figure 3-3, Detail A). Press latch (5) on back of Camera (2) to allow focusing panel cover (1) to spring open, exposing ground glass (6).

e. (See Figure 3-3, Detail D). On camera front standard (18) rotate Camera Speed Scale (19) until "T" on Speed Scale is opposite Speed Pointer (21) on shutter/lens system (22).

f. Set Aperture Indicator (24) to f/4.7.

g. To open shutter (23), press and hold down Shutter Release Lever (25). While holding Shutter Release Lever down, gently set Cocking Lever (20) to right, then release Cocking Lever. Release Shutter Release Lever.

RESULT: (1) Shutter (23) opens and stays open.
(2) Image (probably out of focus) can be seen on ground glass (6, Detail A).

h. Look through ground glass (6) and loosen two knurled knobs on Tripod camera mount. Position camera with tripod positioning handle to frame object or scene, then tighten knobs.

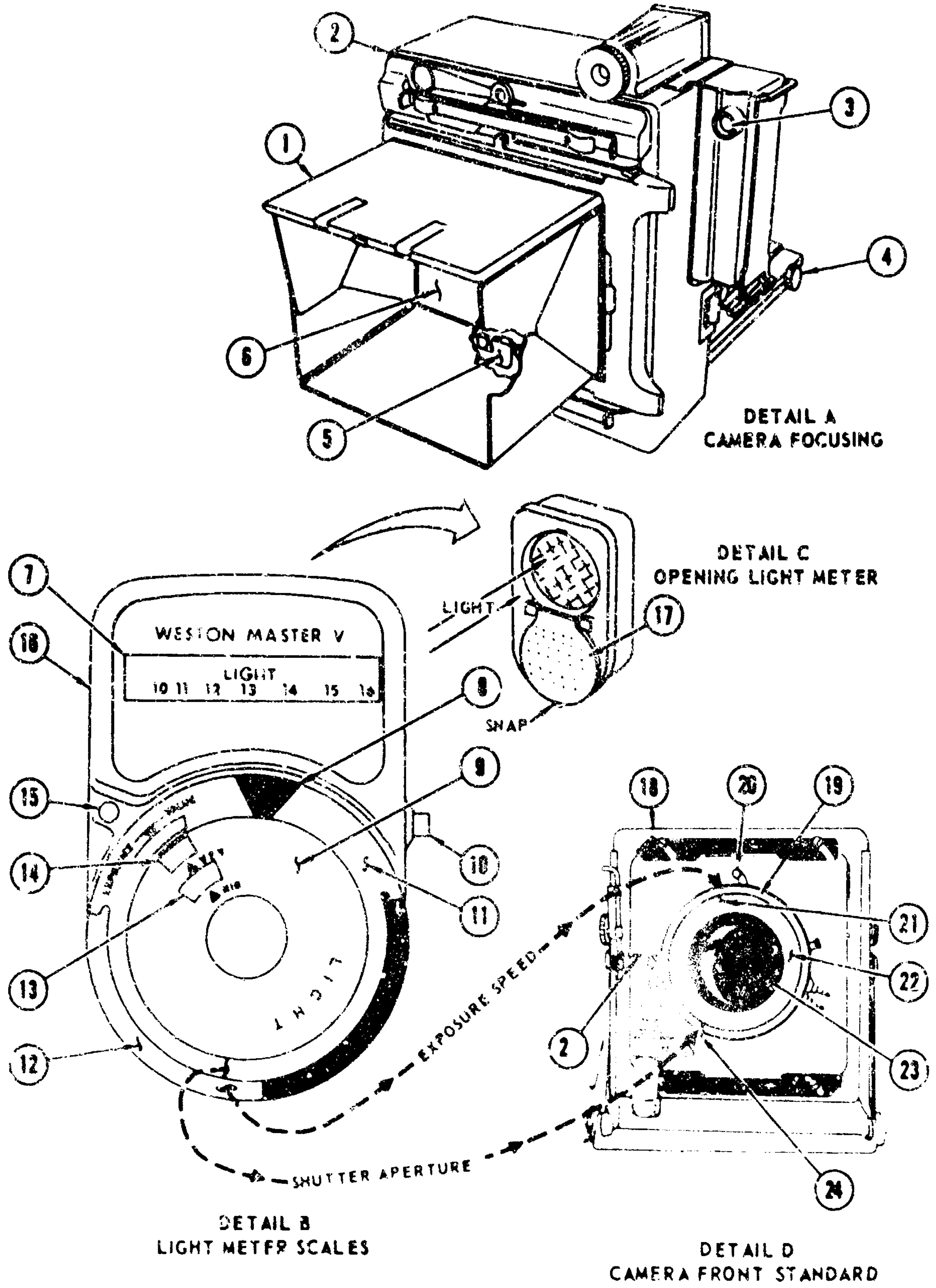


FIGURE 3-3. CAMERA ADJUSTMENT

1. FOCUSING PANEL COVER
2. CAMERA
3. RANGE FINDER WINDOW
4. FOCUS CONTROL
5. LATCH
6. GROUND GLASS
7. LIGHT WINDOW
8. ARROW
9. LIGHT SCALE
10. INDICATOR BUTTON
11. APERTURE SCALE
12. METER SPEED SCALE
13. "DIN" WINDOW
14. "ASA" WINDOW
15. SCALE BRAKE BUTTON
16. LIGHT METER
17. COVER
18. CAMERA FRONT STANDARD
19. CAMERA SPEED SCALE
20. COCKING LEVER
21. SPEED POINTER
22. SHUTTER/LENS SYSTEM
23. SHUTTER
24. APERTURE INDICATOR
25. SHUTTER RELEASE LEVER

FIGURE 3-3. CAMERA ADJUSTMENT

i. Adjust Focus Control (4) until image on ground glass (6) is correctly focused.

j. Press Shutter Release Lever (25) to close shutter (23).

k. Fold focusing panel cover (1) until latch (5) snaps, holding cover closed.

l. Install Film Holder in Camera. Refer to paragraph 3-11, Installation.

3-15. Range Finder Focusing.

NOTE

Camera may be hand-held or mounted on Tripod when range finder method is used.

a. If Camera is to be mounted on Tripod, perform paragraph 3-5, Mounting Camera on Tripod.

b. Open Camera. Refer to paragraph 3-7, Opening.

c. (See Figure 3-3, Detail A) Look through range finder window (3) and position Camera (2) until object or scene to be focused is in center of field.

d. Adjust Focus Control (4) until double image merges into one clear image. Camera is now in focus.

3-16. Vernier Scale Focusing.

a. Mount Camera on Tripod. Refer to paragraph 3-5, Mounting Camera on Tripod.

b. Open Camera. Refer to paragraph 3-7, Opening.

c. (See Figure 3-2, Detail A) Adjust Focus Control (10) on Camera (2) until known distance value of object or scene matches on sliding track scale (8, Detail A) and camera bed scale (7). Camera should now be in focus.

3-17. FILM EXPOSURE TIME/SHUTTER APERTURE.

See Figure 3-3.

a. Determine ASA or DIN number from Polaroid film packet containing film to be used.

b. (See Figure 3-3, Detail B) Press Scale Brake Button (4) on Light Meter (16) and rotate LIGHT scale (9) until desired ASA or DIN number

appear directly opposite pointer on ASA window (14) or DIN window (13). Release Scale Brake Button. Readjust LIGHT scale to ensure scale pointers are exactly opposite numbers.

c. (See Figure 3-3, Detail C) To determine light value, open cover (17) completely and snap against back of meter. Point rear of Light Meter at object to be photographed. Press and hold Indicator Button (10) until red indicator on LIGHT window (7) stops, then release button.

RESULT: Red indicator holds at Indicated reading.

d. Note LIGHT window (7) reading, then adjust Aperture Scale (11) until arrow (8) is opposite same value on LIGHT scale (9).

e. To determine shutter aperture and exposure speed, decide whether a long exposure or short exposure is desired (long exposure for stationary objects, short exposure for action shots). Long exposure speeds (in seconds) are in red portion of meter Speed Scale (12); short exposure speeds (fractions of seconds) are in silver and black portion of meter Speed Scale. When exposure speed is chosen, find corresponding shutter aperture value on Aperture Scale (11) opposite chosen meter Speed Scale value (do not move scales).

f. (See Figure 3-3, Detail D) On Camera front standard (18, rotate Camera Speed Scale (19) until chosen exposure speed is opposite Speed Pointer (21). Set Camera Aperture Indicator (24) to shutter aperture value derived from Light Meter.

SECTION IV

OPERATION

4-1. GENERAL.

4-2. Section IV, Operation, provides instructions for using the Camera Set to obtain photographs of objects or scenes.

4-3. TAKING PHOTOGRAPH.

4-4. PREPARATION.

a. If Camera is to be mounted on Tripod, perform paragraph 3-5, Mounting Camera on Tripod.

b. Open Camera. Refer to paragraph 3-7, Opening.

c. Focus Camera at object or scene to be photographed. Refer to paragraph 3-13, Focusing Camera.

d. Set film exposure time and shutter aperture on Camera. Refer to paragraph 3-17, Film Exposure Time/Shutter Aperture.

e. Ensure Film Holder is installed in Camera. Refer to paragraph 3-11, Installation.

4-5. PROCEDURE.

See Figure 4-1.

4-6. Inserting Film.

a. (See Figure 4-1, Detail A) Raise (A) LOAD/PROCESS lever (2) on Film Holder (3) to LOAD.

CAUTION

To prevent damaging development reagent, do not press pod on film packet (4) while inserting packet into Camera.

b. Grasp film packet (4) as shown and insert (B) metal clip into slot in Film Holder (3) (ensure POLAROID name on film packet is positioned as shown). Push film packet about half way into Film Holder.

c. Hold Camera (1) firmly and grasp end of film packet (4), pushing film packet completely into Film Holder (3) until metal clip clicks into position.

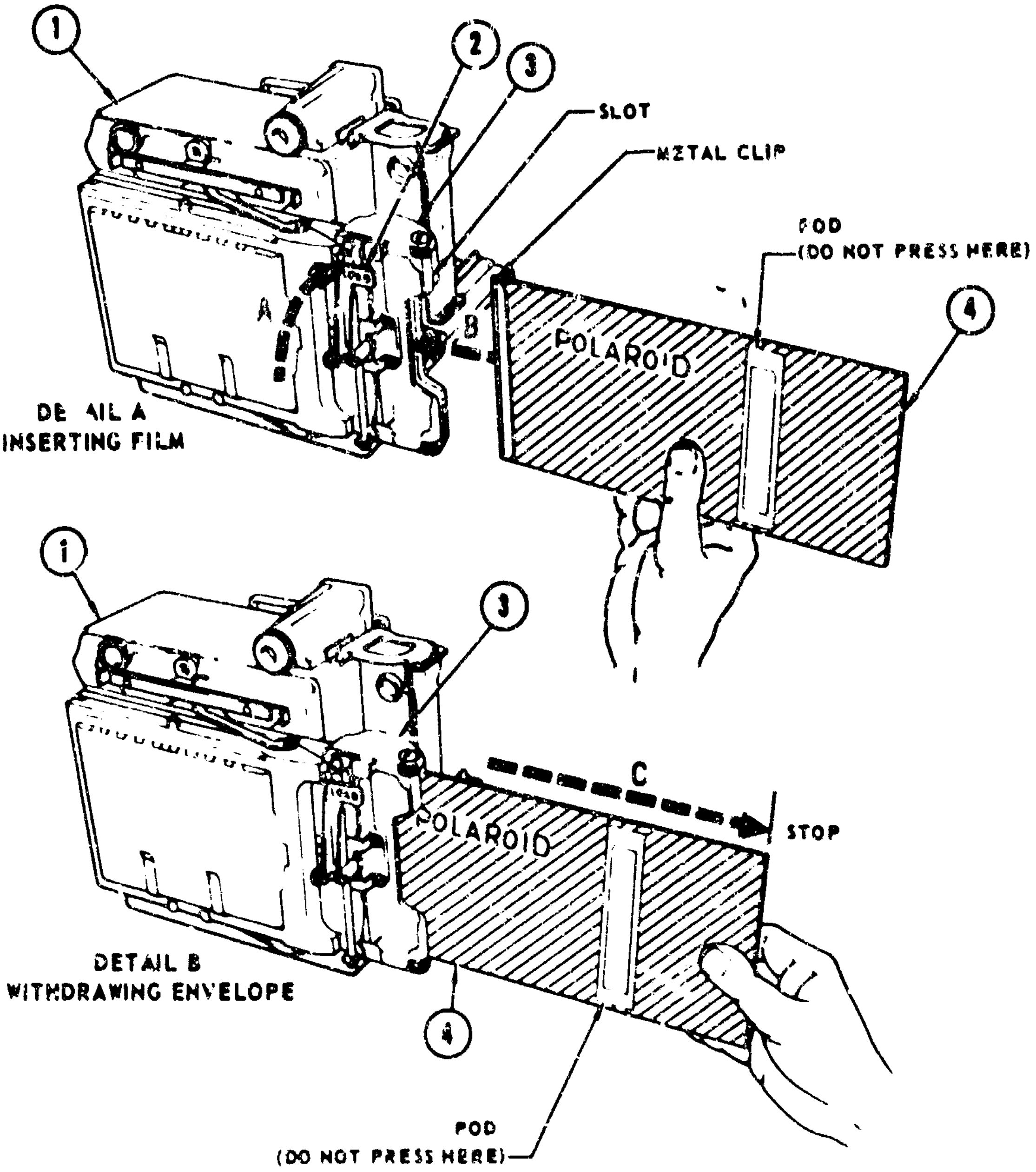


FIGURE 4-1. TAKING PHOTOGRAPH

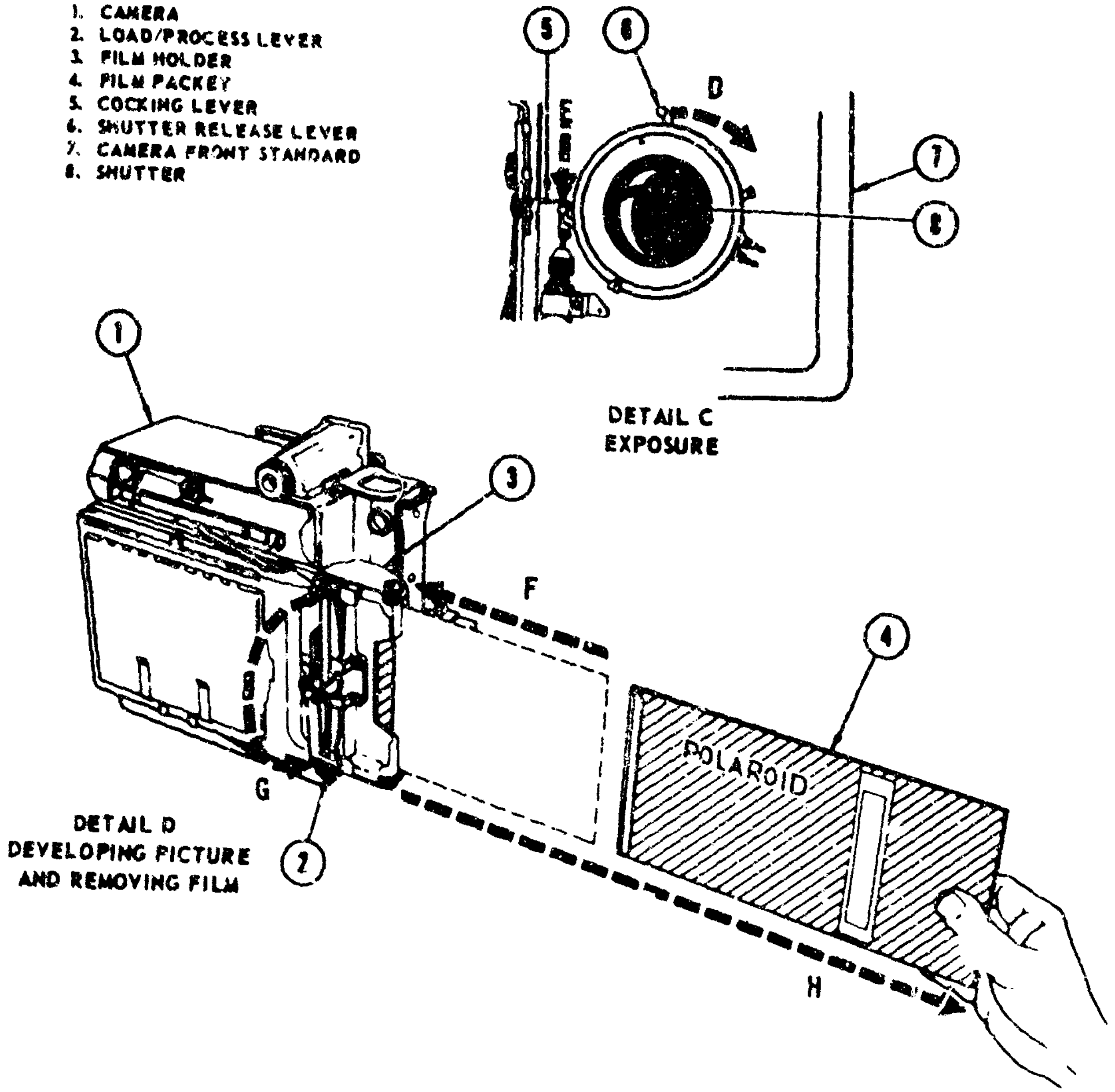


FIGURE 4-1 TAKING PHOTOGRAPH

d. (See Figure 4-1, Detail B) Carefully withdraw (C) envelope of film packet (4) until envelope stops. Lightly run finger over pod on envelope to ensure negative did not come out with envelope. If pod is not flat and smooth, reinsert envelope and repeat step d.

e. Film is now ready for taking picture (exposure).

4-7. Exposure.

a. (See Figure 4-1, Detail C) On Camera front standard (7), push (D) Cocking Lever (5) completely to right.

RESULT: Red dot appears and Cocking Lever remains to right.

b. To expose film, press down (E) on Shutter Release Lever (6).

RESULT: (1) Shutter (3) operates and Cocking Lever moves left to uncocked position.
(2) Camera film is exposed.

4-8. Developing and Removing Film.

a. (See Figure 4-1, Detail D) Reinsert (F) envelope until envelope stops.

b. Lower (G) LOAD/PROCESS lever (2) to PROCESS (development does not begin until following step is performed).

NOTE

Development time for most film is fifteen seconds at 70° F; check film instructions in film box for development time of particular film being used. When film packet (4) is removed in next step, begin measuring development time just as packet leaves Film Holder (3).

CAUTION

To prevent poor developing of film during next step, do not slow down when resistance is felt as packet is withdrawn. To avoid incomplete developer spread do not withdraw packet exceedingly fast. To avoid damaging film do not grasp any portion of Film Holder (3) while withdrawing packet.

c. To develop film, grasp Camera (1) firmly, then grasp end of film packet (4) and rapidly and smoothly pull (H) packet completely out of Film Holder (3). Begin timing development.

WARNING

> Use care to avoid contact with brown, jelly-like developer that is exposed when film packet is opened. Developer is caustic and causes alkali burns upon contact with skin. Keep developer away from vicinity of eyes and mouth. If developer contacts skin, wipe off immediately, then flush with water. Do not allow developer to contact clothes or furniture.

d. When development time ends, open film packet by ripping paper off end opposite from metal clip.

e. Strip sides of film packet and remove developed print.

f. Discard film materials containing caustic developer into a safe container.

g. Ensure print is free from dirt and dust, and apply coating compound (contained in small plastic cylinders included in film box) over print. Coat print completely with six to eight overlapping strokes. Prints should dry within five minutes.

h. If no further photographs are to be taken, close Camera. Refer to paragraph 3-8, Closing.

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13. ABSTRACT

A study was performed to develop new Personnel Subsystem Test and Evaluation (PSTE) techniques for use during Categories I, II, and III Testing of ground operator and maintenance functions. This report describes the development, modification, and refinement of a press camera system as a PSTE technique. Equipment and operational procedures developed for the technique were evaluated under various conditions, including Category II Testing at an Air Force base. Results showed the utility of the camera technique for human engineering and task assessment. Specific recommendations are given for use of this technique from system concept through operational use.

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Maintenance Assessment						
Personnel Subsystem Test and Evaluation (PSTE)						
Polaroid Film						
System Development						
Testing						
Video Tape Recorder (VTR)						
Work Space Envelope						